Experimental study of submarine landslides -Motion mechanism and impact force to cable-

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Experimental study of submarine landslides -Motion mechanism and impact force to cable-

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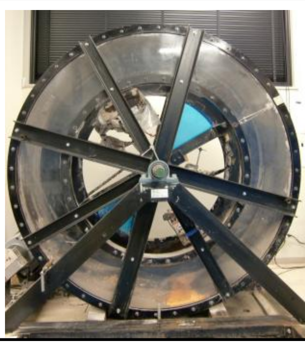
Keywords: motion mechanism, friction, impact force

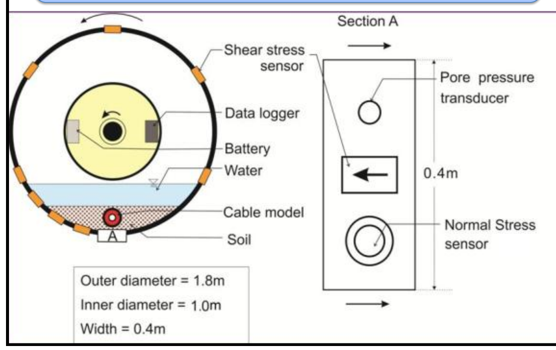
Trouble points of communication cable (1959-2006)

⇒ Of these at least 20% were influenced by submarine landslides and gravity flow

Submarine landslide apparatus



Submarine landslide apparatus



Experiment with some tracers and saturated sand

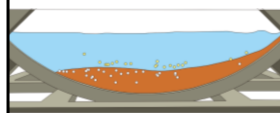
Video clip

Properties of tracers

			
Diameter [mm]	6.0	6.0	11.68
Weight [g]	0.25	0.2	0.838
Specific gravity	1.77	1.06	**1.005**
Movement	Soil	Turbidity current	Water flow

Change in behavior

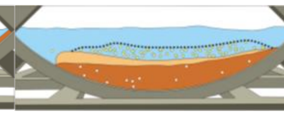
Velocity Ⅰ



Velocity at which the surface of soil mass become turbulent

- Liquefaction occurs

Velocity Ⅱ

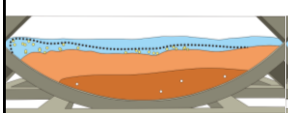


Velocity at which yellow tracers float up and drift with the current

- The layer denser than water appears on the surface of the mixture

Change in behavior

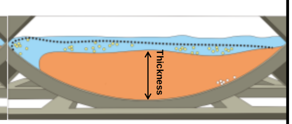
Velocity Ⅲ



Velocity at which white tracers disappear from the front part of soil mass

- The front part of the mixture becomes the turbidity current

Velocity Ⅳ



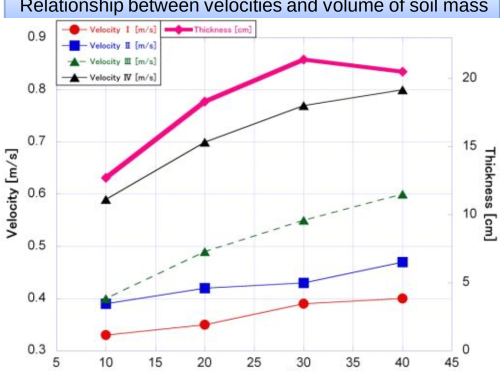
Velocity at which white tracers become to roll on the bottom of the apparatus

- Soil mass becomes turbidity current entirely

Relationship between velocities and volume of soil mass

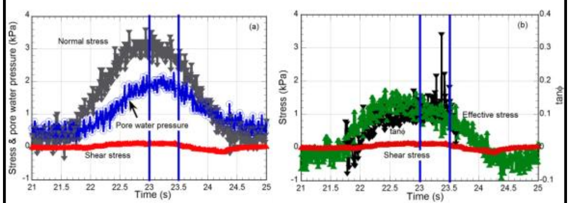
Mass	Velocity Ⅰ [m/s]	Velocity Ⅱ [m/s]	Velocity Ⅲ [m/s]	Velocity Ⅳ [m/s]	Thickness [cm]
40kg	0.40	0.47	0.60	0.80	20.5
30kg	0.39	0.43	0.55	0.77	21.4
20kg	0.35	0.42	0.49	0.70	18.3
10kg	0.33	0.39	0.44	0.59	12.7

Relationship between velocities and volume of soil mass



Measurement of each stresses and pore water pressure

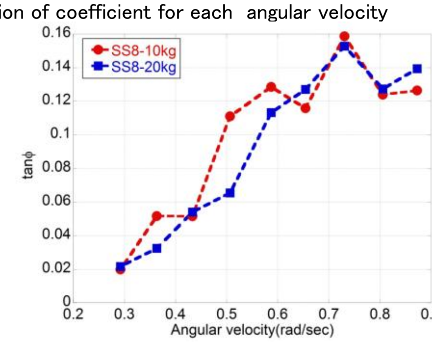
Result from the experiment



$$\tau = (\sigma - u)\tan\varphi \qquad \tau = \sigma' \tan\varphi$$

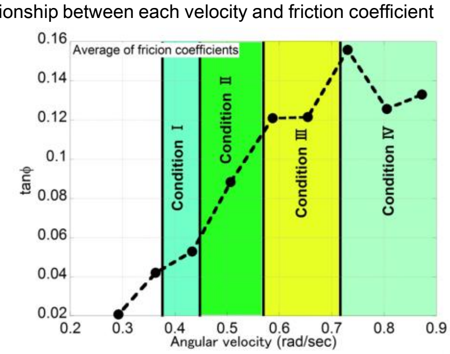
In this test, silica sand no.8 was used, and the angular velocity was 0.58 rad/sec. The peak of pore water pressure means that the set of three sensors comes to the lowest points.

Friction of coefficient for each angular velocity



Friction coefficient became higher when angular velocity increased.
When mass of sand is 10kg or 20kg, friction coefficient is not changed.

Relationship between each velocity and friction coefficient



Friction coefficient is related sand condition.

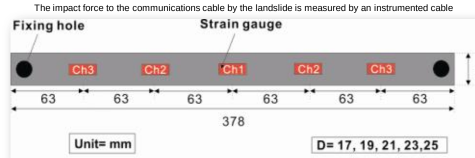
Conclusions

- As volume of soil mass increases, Velocity Ⅰ, Ⅱ, Ⅲ, Ⅳ and thickness of turbidity current tends to increase.
- Friction coefficient became higher when angular velocity increased.
- When mass of sand is 10kg or 20kg, friction coefficient is almost same value.
- Friction coefficient is related sand condition.

Same apparatus study for measurements impact force to model of communication cable

Instrumented cable

The impact force to the communications cable by the landslide is measured by an instrumented cable



The length of the model cable is 0.378 m. Two screw holes were made at both ends to fix the cable to the frame of the apparatus. To measure the impact force, strain gauges were pasted onto the model cable.
Five strain gauges were located at equal intervals on the front and back sides of the model cable, forming three channels (ch).

The impact force to the communications cable by the landslide is measured by an instrumented cable

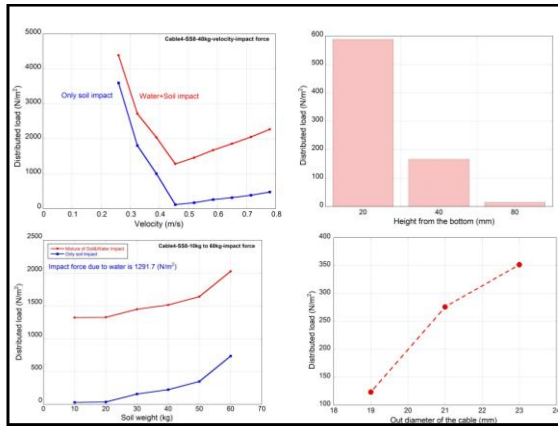
Purpose of study

・Clarification of destructive force and damaging mechanism of cable

Especially, Influence by
- landslide volume
- landslide motion velocity
- soil types of the landslide
- diameter of the cable
- setting height of the cable

The details of experiment patterns are listed below.

Landslide volume (kg) : 10, 20, 30, **40**, 50, 60
Motion velocity (*0.013 m/s) : 20, 25, 30, 35, **40**, 45, 50, 55, 60
Setting height of the cable (mm) : 20, **40**, 80
Diameter of the cable (mm) : 17, 19, **21**, 23
Soil type : Silica sand no.7, **Silica sand no.8**
(Red= basic type of the tests)



Results of the experiments

- At the same velocity, the impact force increased with the soil volume.
- Experiment with setting height 20mm showed largest impact force. And experiments with higher setting (40mm and 80mm) showed lower impact force. This my due to reflect of the difference in the density for every height.
- Larger cables are subjected to larger impact forces. When the diameter of the cable increased for 10% (2mm), the impact force increased almost 50%.